The Interplay of Legal, Temporal, and Social Defenses in the Formation of Corporate Venture Capital Relationships: It Does Take a Village (and More) to Raise a Firm

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ABSTRACT

While inter-organizational network ties offer firms many benefits, ties may also expose firms to dangers such as misappropriation and exploitation by partners. Accordingly, firms may restrict dangerous tie formation to situations in which they are protected by particular defense mechanisms. Yet the identity of the main defense mechanisms, their effectiveness, and their interplay and relative strengths remain unclear. In this study, we identify and examine three key defenses: legal, temporal and social. We argue that social defenses are a superior substitute to legal defenses, and that social and temporal defenses are mutually reinforcing complements. We find strong support for our framework, along with some unexpected nuances, in the formation of over 1,200 inter-organizational investment ties between entrepreneurial firms and established corporations.

> *"They took our ideas and tried to claim them as their own, and they tried to crush a little company" Steve Stone, founder of startup Infoflows, describing his startup's once-promising partnership with established firm Corbis.* (Lohr, 2010)

Inter-organizational ties such as alliances, board interlocks, and equity investment ties are prevalent and important (Brass, Galaskiewicz, Greve, and Tsai, 2004; Gulati, 1995; Paruchuri, 2010; Pfeffer and Salancik, 1978). Such ties beneficially allow firms to share complementary resources, gain access to novel innovations, and alter how they are perceived by others (Podolny, 1993; Sarkar, Echambadi, and Harrison, 2001; Zaheer and Bell, 2005). But they also introduce dangers as one partner may misappropriate the other's resources or adversely alter the other's agenda (Ahuja, 2000; Pfeffer and Nowak, 1976; Wadhwa and Kotha, 2006). Given such tensions, firms are most likely to form dangerous, yet attractive, network ties when protected by defense mechanisms that dampen the exploitation abilities of potential partners (Diestre and Rajagopalan, 2010; Gulati and Gargiulo, 1999; Katila and Mang, 2003).

Defense mechanisms differ in the protections they afford in tie formation and in their ease of use. One classic category is *legal defenses* such as patents and trademarks. Such legal defenses protect a firm's intellectual property from misappropriation by partners, allowing firms to prosecute and seek financial damages from infringing partners (Anton and Yao, 2004; Cohen, Nelson, and Walsh, 2000; Hall and Ziedonis, 2001). Accordingly, intellectual property defenses may discipline partners fearing legal prosecution, while providing infringed firms with recompense should misappropriation nonetheless occur (Agarwal, Ganco, and Ziedonis, 2009; Katila and Mang, 2003; Lerner, 1995). Intellectual property defenses, however, are typically more enforceable and effective in some industries than in others (Heeley, Matusik, and Jain, 2007; Levin, Klevorick, Nelson, and Winter, 1987), and are relatively expensive, especially for resource-constrained firms. Thus, in industries with weak intellectual property regimes and for

resource-poor firms, legal defenses may not be equally effective (Gulati and Singh, 1998; Katila, Rosenberger, and Eisenhardt, 2008).

Other research suggests that firms may protect their intellectual property such as technology and resources from partners through *temporal defenses*, that is, by delaying tie formation until a time when the firm is sufficiently mature so as to be less-dependent on a partner and its technology more protected by complementary resources (Katila and Mang, 2003; Teece, 1986). Because a temporal defense may more fully protect a firm's inventions and does not involve explicit upfront costs, recent research suggests that relatively vulnerable entrepreneurial firms may rely more on temporal defenses than on legal defenses to protect themselves in the formation of potentially dangerous ties (Katila et al., 2008).

Yet other studies suggest *social defenses* as a significant mechanism that protects against opportunistic partners (Ahuja, 2000; Coleman, 1988; Powell, 1990). A firm is protected by social defenses if it is able to sanction a partner's misbehavior by enlisting other firms to either terminate current ties, or to refuse to form new ties, with the partner (Burt, 2005; Gulati, 1995; Raub and Weesie, 1990). Social defenses arise from a firm's prior embeddedness in inter-organizational networks, which provide the trust and information-broadcasting mechanisms needed for such collective sanctioning (Granovetter, 1985; Gulati and Gargiulo, 1999; Wong and Boh, 2010). Thus, when interacting with more embedded firms, partners may be more disciplined in their behavior for fear of being deprived of current and future ties (Gulati, 1995; Hallen, 2008; Soda, Usai, and Zaheer, 2004). Social defenses arising from greater network embeddedness are thus a third defense mechanism that may also enable firms to safely form network ties that might otherwise be too dangerous.

Collectively, prior research suggests that legal, temporal, and social defenses may each afford firms some protection in network tie formation. Yet many firms have a choice amongst these defenses and many gaps remain in our understanding of their effectiveness, interplay, and relative strengths. First, the relationship of social defenses to legal and temporal defenses in tie formation remains unclear. That is, do a firm's social defenses serve as a substitute or a complement to legal and temporal defenses? If a substitute, to what extent are social defenses a superior or an inferior substitute? If a complement, is the effect simply additive with two types of defenses providing greater protection than one, or is the relationship more complex – e.g., one defense is only used in combination with another? Second, although related studies have examined social and legal defenses as complementary governance mechanisms in already formed ties (Poppo and Zenger, 2002; Ryall and Sampson, 2009), we do not know how these defenses play out in tie formation. It seems likely that the decision calculus by which firms choose to form ties may differ from the calculus of how they then choose to govern those ties. Overall many questions remain about how available defense mechanisms compare and interact to influence the formation of potentially dangerous network ties.

In this paper, we examine the interplay of legal, temporal, and social defenses in the context of entrepreneurial technology firms that form (or not) equity relationship ties with corporate investors (CVCs). Specifically, we theorize about how an entrepreneurial firm's social defenses affect its reliance on and use of legal and temporal defenses. The formation of CVC relationships between young firms and corporate partners is particularly appropriate for this study as such ties may help entrepreneurial technology firms address their high resource needs (Baum, Calabrese, and Silverman, 2000; Rothaermel and Deeds, 2004; Zheng, Liu, and George, 2010), but may also expose these firms to substantial dangers from corporate partners seeking to

misappropriate the young firm's innovations or influence their strategic agenda (Basu, Phelps, and Kotha, 2009; Diestre and Rajagopalan, 2010; Santos and Eisenhardt, 2009). Building on the network literature's distinction between *structural network embeddedness* and *positional network embeddedness* (Gulati and Gargiulo, 1999; Shipilov, 2005) and extending this distinction to social defenses, we explore how an entrepreneurial firm's willingness to form CVC relationships is impacted by both its geographic proximity to similar firms (structural social defenses) and by its affiliations with high-status venture capital firms (positional social defenses). We then use round-level data of 701 young firms across five U.S. technology-intensive industries from 1979 to 2003 to examine the extent to which legal, temporal, and social defenses serve as substitutes or complements in the formation of CVC relationships.

There are several contributions. First, to the literature on the use of defenses in network tie formation, we enumerate the full range of defenses available to firms, including legal, temporal, and social, and clarify the relative advantages and limitations of each defense mechanism. We show that social defenses (especially structural social defenses) are a superior substitute to legal defenses, but that social defenses and temporal defenses are mutually reinforcing complements.

Second, we contribute to the literature on defenses arising from network embeddedness (Ahuja, 2000; Coleman, 1988; Gulati, 1995; Powell, 1990). Here we offer a more granular and nuanced perspective on social defenses, differentiating between the structural social defenses and the positional social defenses arising from different forms of network embeddedness. Moreover, we unexpectedly find that structural social defenses appear to afford greater protection than positional social defenses.

Third, our findings also contribute to the literature on entrepreneurship and the advantages that entrepreneurial firms may enjoy from either being located in entrepreneurially dense regions or having high-status venture capital investors (Gulati and Higgins, 2003; Saxenian, 1994). We extend this work by showing that firms in entrepreneurially dense regions or with high-status investors may enjoy greater social defenses, and may thus be able to safely engage partners who might be too dangerous for less-embedded entrepreneurial firms.

THEORETICAL ARGUMENTS

In the hypotheses that follow we explore how an entrepreneurial technology firm's network embeddedness, and the social defenses arising from such embeddedness, impacts the firm's reliance on legal and temporal defenses in network tie formation. We define network embeddedness as a firm's formal and informal relationships with other firms (Granovetter, 1985; Podolny, 2001; Uzzi, 1997). In conceptualizing a firm's network embeddedness, we build on Gulati and Gargiulo's (1999) distinction between *structural network embeddedness* and *positional network embeddedness* as two types of embeddedness likely to impact a firm's social defenses and openness to partnering with a particular type of partner[1].

We define *structural network embeddedness* as the extent to which a firm is connected to other firms that are either currently or may in the future share the firm's partners (Gulati and Gargiulo, 1999). Structural network embeddedness emphasizes triadic interactions and the communication of a partner's prior behavior through indirect ties (Ahuja, 2000; Burt, 2001;

[1] Gulati and Gargiulo (1999) also highlight *relational embeddedness*, or the cohesion of the prior relationship between two partnering firms, as a third dimension of social embeddedness. Such dyadic-level embeddedness has been used to explain the strong tendency of firms to engage in tie repetition by forming new ties with prior partners (Gulati, 1995; Kale, Singh, and Perlmutter, 2000). However, given our focus on the formation of ties with new partners, we do not consider relational embeddedness in this study.

Gulati, 1995; Walker, Kogut, and Shan, 1997). A firm with greater structural network embeddedness may retaliate against a misappropriating partner by alerting the current and potential partners to any misappropriation or exploitation; the alerted partners and potential partners may then sanction the offending partner by terminating existing relationships and by refusing to form new relationships (Gulati, 1995; Raub and Weesie, 1990; Soda, Usai, and Zaheer, 2004). Fearing such social sanctioning, the partners of firms with greater structural embeddedness are more likely to behave appropriately. Accordingly, firms with greater structural network embeddedness should enjoy greater *structural social defenses* in otherwise dangerous network ties.

In the context of entrepreneurial firms considering investment ties with corporations, a key type of structural network embeddedness is whether or not a firm is geographically located within a large cluster of similar firms. For a given type of economic activity, there often exist a few regions with a particularly high number of similar firms – e.g., banking in New York City and London, defense firms in Los Angeles and Washington D.C., and technology entrepreneurship in Silicon Valley and Boston (Krugman, 1991; Sorenson and Audia, 2000). Within such clusters, geographic proximity may foster informal ties across firms through local employee mobility and participation in community activities (e.g., country clubs, professional activities, religious organizations, etc.) (Almeida and Kogut, 1999; Feld, 1981; Kono, Palmer, Friedland, and Zafonte, 1998; Rosenkopf and Almeida, 2003; Saxenian, 1994). Such informal ties may also foster the development of greater formal ties (Marquis, 2003; Sorenson and Stuart, 2008), while geographic proximity may increase interaction and knowledge flow in ties (Bell and Zaheer, 2007; Whittington, Owen-Smith, and Powell. 2009). Likewise, to the extent that local firms are perceived as more salient (Hallen, 2010), information shared about a local firm may

diffuse more easily through indirect ties. For these reasons, entrepreneurial firms located within clusters are likely to have a relatively high-level of structural network embeddedness, possessing greater informal and formal, direct and indirect ties to a large number of similar entrepreneurial firms, and these firms may socially sanction an investing corporation in the event of misappropriation or exploitation. Thus, entrepreneurial firms located within clusters are likely to have stronger structural social defenses.

The second key form of network embeddedness is *positional network embeddedness* (i.e., status position). Whereas structural network embeddedness is based on a firm's overall level of connections to similar firms, positional network embeddedness is based on where a firm is located in an overall network structure (Gulati and Gargiulo, 1999; Podolny, 2001; Stuart, 2000) and captures the status and prestige afforded to a firm by its partners (Jensen and Roy, 2008; Podolny, 1993; Shipilov and Li, 2008). Positional network embeddedness is a hierarchical attribute, telegraphing and contrasting a firm's perceived quality relative to the perceived quality of similar firms (Gould, 2002; Pollock and Gulati, 2007; Shipilov, 2005; Zaheer and Soda, 2009). Through such public esteem, firms with higher positional network embeddedness are more likely to capture the attention and influence the behavior of other firms (Haunschild and Miner, 1997; Hsu, 2004; Paruchuri, 2010; Podolny, 1993). Accordingly, a firm with high positional network embeddedness may have a platform from which to sanction a partner by broadcasting their malicious behavior. For example, a high-status firm may be better able to enlist the media or blogs to relay allegations of misappropriation. As the threat of such public shaming may discipline the behavior of otherwise dangerous partners, higher positional network embeddedness may provide partnering firms with stronger *positional social defenses*.

In the context of entrepreneurial firms, a key type of positional network embeddedness is the status of a firm's venture capital (VC) investors. When an entrepreneurial firm receives an equity investment from a well-connected and well-regarded VC investor such as Kleiner Perkins, Sequoia, or New Enterprise Associates, such an investment confers high-status on the entrepreneurial firm. The status-conferring impact of such investments is especially important as equity investments by VCs are often the first formal ties formed by entrepreneurial firms, thus playing a key role in establishing their initial status (Hallen, 2008; Higgins and Gulati, 2006; Lee, Lee, and Pennings, 2000). Accordingly, the higher positional network embeddedness conferred through high-status VC investors is likely to provide entrepreneurial firms with stronger positional social defenses arising from such firms' greater ability for social sanctioning. We turn now to considering the interplay of structural and positional social defenses with legal and temporal defenses in impacting an entrepreneurial firm's formation of potentially dangerous corporate investment ties.

HYPOTHESES

Legal and Social Defenses: Unequal Substitutes

Hypotheses 1 and 2 focus on the relationship between legal defenses and the two forms of social defenses (structural and positional). Entrepreneurial firms may generally perceive corporate investment ties as risky, as corporations may be drawn to such ties to both learn about and possibly appropriate the entrepreneurial firm's technology, as well as to alter a firm's strategic agenda to avoid future competition (Basu, Phelps, and Kotha, 2009; Diestre and Rajagopalan, 2010; Wadhwa and Kotha, 2006). Strong legal defenses, however, may counter technology misappropriation and may make entrepreneurs more comfortable forming investment

ties with corporations (Dushnitsky and Shaver, 2009; Katila and Mang, 2003). In particular, legal instruments in the form of patents and trade secrets may provide entrepreneurial firms with legal recourse in the event of misappropriation by a corporate partner (Anton and Yao, 2004; Gulati and Singh, 1998). Such legal recourse may be especially effective and viable in industries where relatively clear standards exist for assessing infringement of a patent or copyright (Heeley, Matusik, and Jain, 2007; Levin et al., 1987).

Relative to legal defenses, however, social defenses arising from structural network embeddedness and positional network embeddedness may be a more attractive defense for entrepreneurial firms. Whereas enforcing patents or trade secrets may require relatively costly lawsuits that may exceed the financial resources of entrepreneurial firms (Lerner, 1995; Somaya, 2003), social sanctioning by firms with greater structural network embeddedness may require simply alerting informal and formal ties of a partner's misappropriation (Burt, 2005; Wang and Boh, 2010). Similarly, firms with high positional network embeddedness may socially sanction partners by publicly broadcasting allegations of misappropriation via networks, media, and other channels. Likewise, whereas firms may be hesitant to initiate patent or trade secret litigation because of the burden of legal proof, simple allegations of misappropriation may be sufficient to initiate social sanctioning through structural or positional social defenses. Moreover, despite lacking the enforcement of the courts, social sanctioning may still impose severe penalties by depriving the sanctioned partner of partnership opportunities with third parties. Social sanctioning may also provide broader protections than legal defenses, protecting not only a firm's innovations from misappropriation but also defending the firm against attempts to alter its strategic agenda. Thus, for reasons of both efficacy and cost, we propose that entrepreneurial

firms are likely to regard strong social defenses as a superior substitute to a strong intellectual property regime.

> *Hypothesis 1: The stronger the structural social defenses, the less influence the strength of legal defenses has on whether entrepreneurs form investment ties with corporations.*

> *Hypothesis 2: The stronger the positional social defenses, the less influence the strength of legal defenses has on whether entrepreneurs form investment ties with corporations.*

Temporal and Social Defenses: Complements

Temporal defenses protect firms by synchronizing the formation of potentially dangerous network ties with times when a firm is less vulnerable to exploitation. For entrepreneurial technology firms, this often means delaying the formation of such ties until the firm's technology becomes more fully embedded in complementary resources, and thus harder for partners to misappropriate (Gans and Stern, 2003; Katila and Mang, 2003; Lerner and Merges, 1998). Beyond simply protecting innovations from imitation through complementary resources, delaying interdependent ties may also make it more difficult for partners to adversely affect an entrepreneurial firm's product portfolio or technology agenda (Sahlman, 1990). Relative to legal defenses, timing is a conservative defense, reducing the opportunity for potential partners to exploit (versus simply discouraging exploitation). Because of such conservative protections, and also because temporal defenses involve no explicit costs, research has shown that entrepreneurial firms generally prefer temporal defenses to legal defenses in the formation of potentially dangerous ties (e.g., Katila et al. 2008).

Unexplored in extant literature, however, is the relationship between temporal and social defenses. Whereas legal and social defenses both protect firms through the threat of sanctioning and are thus substitutes, temporal and social defenses are more distinct in their underlying mechanisms. That is, temporal defenses a priori limit the possibility for malicious behavior by

restricting tie formation to times when misappropriation or exploitation is intrinsically more difficult. In contrast, greater social defenses provide firms with recourse in the event that malicious behavior does occur. Temporal and social defenses may thus operate in parallel and provide additive defenses, and the combination of the two defenses may offer greater cumulative protection than either alone. Moreover, as each defense involves relatively minor explicit costs, firms are unlikely to perceive a trade-off between temporal and social defenses. Thus, we propose that entrepreneurial firms are likely to perceive social and temporal defenses as complements.

An entrepreneurial firm's use of social and temporal defenses may also be highly correlated, with both defenses depending on a firm's network embeddedness. In the case of social defenses, greater network embeddedness facilitates greater potential for social sanctioning. Similarly, greater network embeddedness may make it easier for firms to form alternative, safer ties, thereby making firms more comfortable with delaying the formation of potentially dangerous ties until they are better protected by temporal defenses. Specifically, in the context of entrepreneurial firms considering investment ties with corporations, greater network embeddedness may make it easier for firms to initially form investment ties with less-dangerous venture capital firms (Hallen, 2008; Shane and Cable, 2002; Sorenson and Stuart, 2001). In contrast, entrepreneurial firms with less network embeddedness may have difficulty initially attracting safer partners, and may be forced to forgo temporal defenses and pursue corporate investors sooner. We therefore propose that social and temporal defenses are likely to be mutually reinforcing complements, with both offering additive protections and both depending on a firm's network embeddedness.

> *Hypothesis 3: The stronger the structural social defenses, the greater the influence of temporal defenses on whether entrepreneurs form investment ties with corporations.*

Hypothesis 4: The stronger the positional social defenses, the greater the influence of temporal defenses on whether entrepreneurs form investment ties with corporations.

METHODS

Sample and Data Sources

We analyze the decision to form corporate investment (CVC) ties by venture capital-backed, high-technology ventures over a 25-year period from 1979 to 2003. The sample of ventures was drawn from the population of U.S. high-technology ventures that received their initial venture funding between 1979 and 1995. We chose venture capital-backed ventures as such backing indicates the promise in the venture's technology and market, suggesting that these ventures are likely to have choice in their formation of ownership ties, including CVC ties (Hellman and Puri, 2000; Davila, Foster, and Gupta, 2003). We chose technology ventures as both the benefits and dangers of CVC investors may be heightened in such ventures due to both the ventures' high resource needs and the generally appropriable nature of their resources. Additionally, because of the multiple paths to technology entrepreneurship, ranging from repeat serial entrepreneurs to young technologists lacking business experience (Burton, Sorenson, and Beckman, 2002; Hallen, 2008), technology entrepreneurs may vary considerably in their network embeddedness and ability to leverage social defenses.

We began the sample in 1979, the year that the U.S. Department of Labor clarified its "prudent man" rule to explicitly allow pension fund managers to invest in high-risk assets, including venture capital (Hochberg, Ljungqvist, and Lu, 2007). This regulatory change greatly increased the supply of venture funding available to ventures in subsequent years (Bygrave and Timmons, 1992; Gompers and Lerner, 2001). We sampled ventures founded through 1995, but continued data collection for rounds occurring through 2003. As a venture generally takes five to

seven years to experience a liquidation event after the first round (Fenn, Liang, and Prowse, 1997), this continued data collection allowed a more complete perspective of venture tie formation by including all funding rounds.

Our unit of analysis was the funding round. Ventures raise their investments in a series of discrete rounds, as investors generally stage their investments around substantial advances in a venture's progress while entrepreneurs seek to match investors' timing and limit distractions from running their firms (Graebner and Eisenhardt, 2004; Hallen and Eisenhardt, 2010; Sahlman, 1990). Data were collected for each venture's funding rounds through either 2003 or until an exit event.

Our key data source was the VentureXpert database. These data were further corroborated and expanded in several ways. VentureXpert includes detailed information about ventures, the venture capital and corporate investors investing in these ventures, and funding rounds. Data in VentureXpert is collected by the National Venture Capital Association, has been found to provide an accurate description of U.S. venture financing (Lerner, 1995; Kaplan, Sensoy, and Stromberg, 2002), and has been used extensively in prior research (Gompers and Lerner, 1999; Guler, 2007; Podolny, 2001). Moreover, this database is well-suited to our study as it enables both an unusually long sampling period of 1979 through 2003 (thus allowing more robust results) and a focus on venture capital-backed technology ventures for whom CVC investors may offer the potential for both substantial benefits and substantial risks.

We triangulate the VentureXpert data with the VentureOne database and Lexis-Nexis media articles in order to improve the comprehensiveness and accuracy of our data sample. Such triangulation is desirable as these databases are drawn from data sources distinct yet complementary to VentureXpert. Specifically, data in VentureXpert are drawn from investor

surveys, VentureOne data are gathered through entrepreneur surveys, and Lexis-Nexis data are gathered from archived corporate press releases and media coverage. By using these complementary data sources, we were able to use multiple informants for each event, thus increasing the completeness and coverage of the data sample. We constructed the sample by first sampling venture rounds from VentureXpert, and then corroborating rounds and specific investments with data from VentureOne. This process was also used to identify data missing in VentureXpert (e.g., investments that VentureXpert identified as "undisclosed"). For data that were either still missing or inconsistent between the databases, we examined media coverage and press releases from Lexis-Nexis. Overall, these efforts added information to roughly 20 percent of rounds, producing a uniquely refined and comprehensive sample of investments in ventures in five industries over 25 years. Finally, and as discussed in the measures section, additional data for independent and control variables that were not available in the investment databases were obtained from other sources such as Compustat, Hoover's, and Securities Data Corporation.

Our sample was a stratified random sample of 701 ventures drawn from the population of high-technology ventures that received their funding in 1979-1995. We stratified the sample by year and by five broad technology industry groups as designated by VentureXpert: medical, biotechnology, communications, electronics, and software. These industry designations represent the five largest general technology industries that received venture funding over the study period, and include over 80 percent of funded technology ventures during this time. Our sample represents approximately 11 percent of the U.S. technology ventures funded during this time period. Overall, these ventures raised 18,168 investments, including over 1,200 corporate investments, in 4,077 funding rounds between 1979 and 2003.

Measures

Our hypotheses address the extent to which a venture's formation of investment ties with corporations is influenced by the availability of legal, temporal, and social defenses. Our primary dependent variable is a discrete count of the *number of corporate venture investors* in a sample venture's funding round. We used a count-based measure to better capture the greater potential for both cooperation and misappropriation associated with a larger number of CVC ties. We coded an investor as corporate if it was a non-financial firm and purchased private equity (we exclude loans and public offerings); we thus excluded subsidiaries of banks and insurance companies to focus on CVC investors that may offer particularly complementary resources and yet may also be more likely to engage in misappropriation. Investors were coded using company directories, annual reports, and databases on public companies (e.g., Compustat and Worldscope). Two researchers independently coded the data with the aid of a computer program that matched inconsistent spellings and repeat investments. We include both U.S. and foreign corporate investors, making our coverage more comprehensive than studies focused on U.S. investors only (e.g., Dushnitsky and Lenox, 2005). Overall, over 1,200 corporate investments were coded.

Social Defense

In our hypotheses we argued that a venture's use of legal and temporal defenses is likely to be influenced by the venture's social defenses. We measured a venture's degree of *structural social defense* by whether or not the venture is located in a geographic cluster of a large number of similar ventures. As noted in the theory, economic clusters are likely to not only possess a large number of similar ventures, but their geographic proximity is also likely to foster ties between these ventures (Feld, 1981; Marquis, 2003; Sorenson and Stuart, 2008). Accordingly,

entrepreneurial firms in economic clusters are likely to have greater structural social defenses. In the context of young high-technology ventures in the U.S., two regions with particularly high levels of entrepreneurial activity are San Francisco and Boston (Bygrave and Timmons, 1992; Gompers and Lerner, 2001; Saxenian, 1994). We thus included *structural social defense* as a binary variable with a value of 1 if the venture is located in either San Francisco or Boston and zero otherwise. Each venture's zipcode was collected from VentureXpert (or VentureOne and LexisNexis if necessary) and was time variant. Consistent with Saxenian (1999), we defined Boston as Middlesex, Norfolk, and Essex Counties, and San Francisco to include San Francisco, Alameda, San Mateo, and Santa Clara Counties.[2]

We measured *positional social defense* in our context by the status of a venture's existing and current venture capital investors. As they are often the earliest formal ties formed by young organizations (Hallen, 2008), the presence or absence of high-status venture capitalists exerts a substantial influence on how a young venture is externally perceived (Higgins and Gulati, 2003; Pollock et al., 2010; Stuart, Hoang, and Hybels, 1999). We measured *positional social defense* as a binary variable that takes a value of one if any of a venture's existing or current investors is one of the thirty highest-status early-stage venture capital investors and zero otherwise. This distinction between elite and more modest / low positional embeddedness is consistent with our theory and prior literature (Gulati and Higgins, 2003; Guler, 2007). Following prior studies, we measured status using eigenvector centrality as it accounts for both a firm's connectedness and the connectedness of the firm's partners (Bonacich, 1972; Guler, 2007; Hochberg et al., 2007; Podolny, 2001). We focus on early-stage venture capital investors, categorized as those investing

[2] While we would ideally be able to directly measure the extent and span of a venture's informal and formal, direct and indirect ties to a large number of similar ventures, such data are unfortunately difficult to feasibly collect in a large-sample, multi-decade study such as ours. We therefore follow the convention of using entrepreneurially dense regions as a suitable proxy for strong structural network embededdness.

in research, product development, and initial manufacturing phases, as they are generally more active in establishing a venture's initial status (Bothner, Lee, and Kim, 2010; Hallen, 2008). We also confirmed the validity of our list of thirty high-status VC investors by consulting with a partner at a venture capital firm and with an angel investor.

Legal and Temporal Defenses

We used two measures of the strength of legal defenses available to an entrepreneurial firm. First, we measured the efficacy of *patent defense* in a venture's industry. Patents are a protection instrument that establishes a legal right for a holder (e.g., a venture) to exclude others (e.g., a CVC investor) from using an invention (Anton and Yao, 2004; Dushnitsky and Shaver, 2009; Katila and Mang, 2003). When granted by the U.S. Patent and Trademark Office, patents allow holders to prosecute others who infringe, regardless of the source of the infringer's idea (Walker, 1995). Since the strength of patent protection varies across industries, engaging CVC investors may be less dangerous for ventures in industries with high levels of patent protection. We measured the patent defense in a venture's industry using the Carnegie Mellon Survey of industrial R&D (Cohen, Nelson, and Walsh, 2000), matching industries at the 3-digit SIC code level at which the survey was conducted. Our specific measure is the percentage of product inventions in the industry for which surveyed R&D managers believed patents to be effective in preventing appropriation. These data have been used extensively in prior studies and are considered the primary source on comparative appropriability (Arora and Ceccagnoli, 2006; Gulati and Singh, 1998; Shane, 2002). Further, the collection date of these data (1994) is at the approximate midpoint of our time range (1979-2003).

We also measured the strength of legal defenses through the efficacy of *secrecy defense* in the venture's industry. As noted above, trade secrets are an alternative legal protection

mechanism that may protect an organization's ideas. Whereas ideas protected by patents need to be novel, useful, and non-obvious, trade secrets protect a broader range of ideas as long as organizations keep them secret (Epstein, 2004). Trade secrets are thus an effective protection mechanism for many ventures concerned about misappropriation by CVC investors, as both using improper means to discover trade secrets and the use of improperly attained trade secrets is illegal. To help protect their trade secrets, organizations often use legal contracts such as nondisclosure agreements, material transfer agreements, and non-compete clauses (Scotchmer, 2004). As with patents, the strength offered by trade secrets varies across industries. To assess the strength within a particular industry, we again used the Carnegie Mellon Survey of industrial R&D (Cohen, Nelson, and Walsh, 2000). Our measure is the percentage of product inventions for which trade secrets are considered an effective protection mechanism in the industry; again, we matched industries at the 3-digit SIC code level.

We measured a venture's *timing defense* by the investment round (e.g., first, second, etc.) and logged this measure to reduce skewness. This measure captures shifts in a venture's willingness to engage corporate investors as a venture matures and misappropriation becomes more difficult (Katila and Mang, 2003; Lerner and Merges, 1998). Investment round is an appropriate measure as it reflects sufficient continued development of technologies and customers to the point that investors are willing to invest in a new round – i.e., these rounds capture the number of 'proofpoints' that a venture has reached (Hallen and Eisenhardt, 2010; Shane and Stuart, 2002).

Controls

We include several controls to account for a venture's need for and ability to attract CVC investors. We measured a venture's general need for greater capital infusions (typically uniquely

available from CVC investors) by *round size* in thousands of U.S. dollars raised in the focal funding round. This is an effective measure of a firm's capital needs as entrepreneurs determine the size of a round by balancing their firm's capital requirements against unnecessary ownership dilution from excessive funding (Gompers and Sahlman, 2002). Given the long time period of the sample, we used the producer price index (PPI) to adjust the round amount for inflation. We also logged the measure to mitigate skewness.

We also controlled for complementary resource needs because ventures may be drawn to CVC investors because they offer two particular types of resources unavailable from other types of investors: manufacturing and marketing (Geletkanycz and Hambrick, 1997; Gulati and Westphal, 1999). First we controlled for a venture's need for manufacturing resources to commercialize its products through *manufacturing intensity*. We measured manufacturing intensity as the capital intensity of the venture's industry since ventures in very capital intensive industries are likely to need greater manufacturing assets to produce their products. Using Compustat data, our measure of capital intensity was the average ratio of fixed assets to sales in the venture's industry in the focal year. Second, as ventures with high *marketing intensity* may seek corporate investors for their brand name, market knowledge, and distribution channels (Basu, Phelps, and Kotha, 2009; Khaire, 2010), we measured the need for marketing resources through the average ratio of advertising expenditures to sales in the venture's industry using Compustat data. Because the need for specific complementary resources is closely associated with a venture's industry (Arora and Gambardella, 1990; Katila and Shane, 2005) and given the difficulties in capturing venture-level data in large-sample, multi-decade studies such as ours, we measured both manufacturing and marketing intensity at the industry level using the granular 4-

digit Standard Industrial Classification (SIC) codes. When unable to locate a preassigned SIC code for a venture, we used the procedure documented in Dushnitsky and Lenox (2005).

To better account for the aging of ventures (as distinct from the maturing of their intellectual assets), we also controlled for *venture age* with data from VentureXpert on the number of months between a venture's founding and the focal round. This measure was logged to reduce skewness. Likewise, to account for the maturing and expansion of the venture industry, we controlled for the *calendar year*. Additionally, we included dummy variables to control for any unobserved *industry effects*. We included dummy variables for the industry segments of biotechnology, communications, software, and electronics, with medical industry as the omitted variable. These industries were based on ventures' SIC codes.

Statistical Methods

Our analyses use negative binomial regressions to estimate the number of CVC investment relationships formed by each venture in a given funding round. To control for venture heterogeneity, we used the Generalized Estimating Equations (GEE) regression method. This method accounts for autocorrelation that arises because each venture was included in the sample through all of its funding rounds (Liang, Zeger, and Qaqish, 1986). We report standard errors derived from the Huber/White robust estimator of variance, which is not sensitive to the choice of correlation structure in the GEE regressions. As compared to random effects, the GEE method does not require the strong assumption that unobserved venture-specific effects are uncorrelated with the regressors.

RESULTS

Table 1 reports descriptive statistics and correlations for the variables. Ventures raised an average of four to five rounds, and the size of an average round was $4 million. Most rounds involved four investors on average. Overall, the correlations between the independent variables were low, thus reducing concerns about possible bias due to multicollinearity. The exception is the correlation between the timing defense and firm age variables ($r = 0.55$). Accordingly, we included both variables separately and simultaneously, but the results were unaffected by this choice.

-- Insert Table 1 around here --

In our hypotheses, we argued that a venture's use of legal and temporal defenses in the formation of corporate investment ties will vary with the venture's social defenses. Accordingly, our focus is on the interactions between the measures of legal and temporal defenses (*patent defense*, *secrecy defense*, and *timing defense*) and the measures of structural and positional social defenses.

-- Insert Table 2 around here --

Table 2 presents the results for the GEE negative binomial regression analysis estimating the number of CVC investment relationships formed by a venture in a given investment round. Model 1 in Table 2 includes the control variables and the measures of legal and timing defenses. Model 2 adds the measures for structural and positional social defenses. We find that ventures form CVC relationships when their intellectual property is strongly protected by trade secrets ($p<0.10$) and later timing ($p<0.01$), but that CVC relationship formation is not influenced by stronger patent protection. Although patents are a commonly emphasized legal defense in the strategy literature (Cohen et al., 2000; Gulati and Singh, 1998; Levin et al., 1987), the non-

significance of patent defense is consistent with recent research that argues that ventures avoid relying on patents due to the large upfront costs, the disadvantageous disclosure of innovations and intentions to potential competitors, and the fact that strong patent protections may deter corporations seeking to learn about a venture's technology (Dushnitsky and Lenox, 2005; Katila et al., 2008). We also find that ventures on average are generally more likely to form CVC investment relationships in rounds that are larger ($p<0.01$) and if they need more manufacturing resources ($p<0.01$). Model 2 also indicates that ventures that are located in Silicon Valley or Boston, and thus protected by structural social defenses, or more likely to form CVC relationships.

We test our hypotheses in models 3 through 5, which add the interactions between the measures of social defenses and the measures of legal and temporal defenses. Model 5 is the full model. The coefficients are mean centered to reduce possible multicollinearity bias (Cronbach, 1987). We argued in hypothesis 1 that structural social defenses are a superior substitute to legal defenses (patents and trade secrets), and that ventures with greater structural social defense will be less influenced by the strength of legal defenses in their CVC tie formation. We find support for hypothesis 1 as the interaction of *structural social defense* and *secrecy defense*, and the interaction of *structural social defense* and *patent defense,* are negative and significant in both models 3 and 5 (the trade secret interaction is significant at the $p<0.01$ level in both models; the patent interaction is significant at the $p<0.05$ level in model 3 and the $p<0.10$ level in model 5). Although the main effect of patent defense does not reach significance, making the interpretation of the patent interaction more complex, both interaction results strongly confirm that ventures with structural social defenses are less influenced by the presence of strong legal defenses in

their formation of CVC ties; accordingly, we find support for hypothesis 1 and our argument that structural social defenses are a superior substitute to strong legal defenses.

We argued in hypothesis 2 that positional social defenses are also a superior substitute to legal defenses (patents and trade secrets). We test hypothesis 2 in models 4 and 5. The interaction between *positional social defense* and *secrecy defense* is negative and significant in model 4 ($p<0.05$) and negative (although not statistically significant) in model 5. Again, the interaction between *positional social defense* and *patent defense* is negative and significant in both models ($p<0.05$ in model 4; $p<0.10$ in model 5). As with structural social defenses, while the main effect of patent defense does not reach significance and the interpretation of the patent interaction is thus complex, the results collectively confirm that ventures with positional social defenses are less influenced by strong legal defenses. Therefore, we also find support for hypothesis 2 and the argument that positional social defenses are a superior substitute to strong legal defenses.

We argued in hypotheses 3 and 4 that social and temporal defenses offer complementary protections and are likely to be used in parallel given their underlying dependence on a firm's network embeddedness. First, we find support for hypothesis 3 as the interaction of *structural social defense* and *timing defense* is positive and significant in both model 3 ($p<0.05$) and model 5 ($p<0.10$). Thus, firms are more likely to form CVC relationships when they are protected by both stronger structural social defenses and later timing. Overall, we find that social structural defenses and temporal defenses are complements.

Similarly, we also find support for hypothesis 4 and the complementarity of positional social defenses and temporal defenses, as the interaction of *positional social defense* and *timing defense* is positive and significant in both model 4 ($p<0.05$) and model 5 ($p<0.10$). Thus,

entrepreneurs are more likely to form CVC relationships when they have both stronger positional social defenses and later timing. Overall, the results in Table 2 support hypotheses 3 and 4, and suggest that social and temporal defenses are mutually reinforcing complements.

Robustness Tests

We also conducted additional robustness tests to account for alternative explanations and to explore sensitivity to our measures. With regards to structural embeddedness, one possible alternative explanation for the observed effect of structural social defenses is that the differences across geographic locations could be driven not by differences in social defenses but instead by variance in regional institutional logics of tie formation (Marquis, 2003; Lounsbury, 2007; Shipilov, Greve, and Rowley, 2010). We tested this alternative explanation by exploring possible differences between CVC tie formation in Silicon Valley and Boston. While these two regions may be similar in providing greater structural social defenses, prior authors have suggested that these two regions differ in their entrepreneurial cultures (Saxenian, 1994). We found that ventures in Silicon Valley and Boston exhibit similar CVC tie formation behavior – thus suggesting that our geography-related results are primarily driven by structural social defenses and not by differences in institutionalized logics of tie formation.

We also ran additional models to explore sensitivity to our measures. With regards to positional social defenses, we ran alternative specifications that measured positional social defenses as to whether a venture had an investment from one of the ten most central venture capital firms (versus one of the thirty most central). These results were consistent with those reported, suggesting that high-status venture capital firms (and not just the highest-status venture capital firms) provide ventures with positional social defenses. With regards to timing defenses, we ran alternative models to test for a linear (versus a curvilinear) relationship between venture

maturity and CVC tie formation. The curvilinear effect, however, improved the model fit more. This suggests that while ventures generally do utilize temporal defenses and avoid CVC investors in early rounds, they are less likely to include CVC investors in late-stage rounds when a venture is very mature and less likely to benefit from the resources offered by CVC investors. Finally, to better understand the overlapping effects of a venture's structural and positional social defenses, we also ran a split-sample analysis. We used a 4-way split, with separate models for ventures with both structural and positional social defenses, only structural social defenses, only positional social defenses, and no social defenses. As expected, these results were consistent with those reported. Overall, these alternative models broadly confirmed the robustness of our results.

DISCUSSION

We explored how an entrepreneurial technology firm's social defenses impact its use of legal and temporal defenses in the formation of potentially dangerous corporate investment relationships. Our first contribution is to the literature on defenses in inter-organizational tie formation (Gulati and Gargiulo, 1999; Lerner and Merges, 1998; Raub and Weesie, 1990; Teece, 1986). We extend prior work by enumerating the full range of tie formation defenses available to firms, including legal, temporal, and social, and by clarifying their interplay, advantages, and limitations. Our arguments and findings show that social defenses are a *complement* to temporal defenses, but that social defenses (especially structural social defenses) are a *superior substitute* to legal defenses. In this way we offer a revised perspective on the defense hierarchy developed by Katila and co-authors (2008). They suggest that entrepreneurial firms generally are more likely to rely on temporal defenses than on legal defenses in the formation of potentially dangerous ties. In contrast, we do not observe a simple linear hierarchy, but instead find an

"inverted pyramid" such that legal defenses are dominated by the complementary mechanisms of temporal and social defenses.

Our findings also contribute to prior literature on the formation of potentially dangerous network ties by offering a more granular and nuanced understanding of social defenses. Here we offer the insights that there are different forms of social defense, and that these different social defenses vary in their relative protections. Building on prior literature's distinction between structural network embeddedness and positional network embeddedness (Gulati and Gargiulo, 1999; Shipilov, 2005), we differentiate between structural social defenses and positional social defenses. Consistent with our theory, our findings indicate that both structural and positional social defenses are indeed a superior substitute to legal defenses. We find, however, that the impact of structural social defenses on tie formation is more significant than that of positional social defenses (note the changes in model fit), indicating the superiority of structural social defenses over positional social defenses. We believe that underlying this difference is that whereas greater structural network embeddedness may relay allegations of misappropration through ties overlaid with personal relationships and relatively high levels of trust (Davis and Greve, 1997; Gulati and Gargiulo, 1999; McFadyen and Cannella, 2004), higher positional network embeddedness is more likely to rely on public allegations that may lack such personal embeddedness and trust. Accordingly, higher positional network embeddedness may be less able to motivate third parties to engage in social sanctioning. Overall, our findings unexpectedly indicate that structural social defenses may afford greater protection than positional social defenses.

Our findings also contribute to the literature on network tie formation by clarifying the relationship between extant network embeddedness and tie formation defenses (Ahuja, 2000;

Granovetter, 1985; Gulati, 1995; Powell, 1990). Prior literature has traditionally emphasized how greater network embeddedness affords social defenses through the threat of social sanctioning. While supporting the efficacy of such social defenses, our theory and evidence indicate that greater network embeddedness *also* protects firms by making them more willing to engage in temporal defenses. This suggests that firms may vary substantially in their potential for safely engaging otherwise dangerous partners, as firms with greater network embeddedness may be able to both avoid dangerous ties when the firm is most vulnerable (via temporal defenses) while also credibly threatening social sanctioning when such ties do form (via social defenses). In contrast, firms with lower network embeddedness may face the less desirable alternatives of either relying on relatively weaker legal defenses (which is riskier) or avoiding such ties altogether. In this manner, our findings extend literature highlighting the self-reinforcing advantages of greater network embeddedness (Gulati and Gargiulo, 1999; Podolny, 1994; Sorenson and Stuart, 2001).

Finally, our research also contributes to literature on entrepreneurship and the benefits to entrepreneurial firms of either being located in economic clusters (Chung and Kalnins, 2001; Saxenian, 1994) or having high-status venture capital investors (Gulati and Higgins, 2003; Hochberg et al., 2007; Stuart et al., 1999). Much of this literature has generally highlighted the informational and resource benefits that entrepreneurial firms gain from such network embeddedness - e.g., greater ability to identify promising entrepreneurial opportunities, greater access to capital and other resources, improved labor pool, etc. Our study expands on this list of benefits by suggesting that entrepreneurs in entrepreneurially dense regions or with high-status investors also benefit from greater social defenses. Accordingly, entrepreneurs in Silicon Valley or Boston or with venture capital investors such as Kleiner Perkins, Sequoia, or Accel are more

likely to be able to safely form ties with partners who might be too dangerous for less-embedded firms. In this way, our study extends nascent work (Hallen, 2008; Marquis, 2003) on how regions and early network ties imprint an entrepreneurial firm's subsequent network tie formation. Moreover, our research also suggests that the range of effective strategies available to entrepreneurial firms varies with their geographic location and status.

CONCLUSION

We began by observing that though prior literature has recognized the use of various defense mechanisms in enabling firms to form otherwise dangerous network ties, the effectiveness and the interplay of these defense mechanisms in tie formation has remained unclear. We elaborate that social defenses (especially structural social defenses) are a superior substitute to legal defenses, but that social defenses and temporal defenses are complements. At a broader level, our study identifies substantial interdependencies between these protective mechanisms, highlighting the importance of managers and researchers taking a holistic perspective of defenses in network tie formation.

TABLE 1: DESCRIPTIVE STATISTICS AND PEARSON CORRELATIONS

		Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1	Number of CVCs	0.29	0.64										
2	Secrecy defense	0.01	0.11	0.07									
3	Patent defense	0.01	0.26	-0.03	0.05								
4	Timing defense	0.06	3.34	0.02	0.02	-0.004							
5	Structural social defense	0.10	0.50	0.06	0.06	-0.01	0.01						
6	Positional social defense	0.08	0.50	0.02	-0.02	-0.001	0.02	0.18					
7	Round size	-0.02	2.86	0.19	0.02	-0.02	-0.09	0.05	0.15				
8	Manufacturing intensity	-0.04	0.47	0.02	0.07	-0.01	-0.02	-0.11	-0.07	0.06			
9	Marketing intensity	0.01	0.04	0.05	0.19	0.14	-0.004	0.11	-0.07	0.06	0.005		
10	Age	3.56	1.23	0.03	-0.03	-0.01	0.55	-0.02	-0.06	-0.03	-0.01	-0.02	
11	Calendar year	1989.69	4.54	0.03	-0.01	-0.02	0.40	0.04	-0.01	0.09	0.18	0.22	0.33

N = 4,077.

TABLE 2: GEE NEGATIVE BINOMIAL REGRESSION ANALYSIS OF THE NUMBER OF CORPORATE INVESTORS (701 VENTURES, 4,077 FUNDING ROUNDS)

	1	2	3	4	5
Legal Defenses					
Secrecy defense	0.556 **	0.471 *	0.936 ***	0.558 **	0.946 ***
	(0.245)	(0.244)	(0.268)	(0.250)	(0.271)
Patent defense	-0.111	-0.109	-0.082	-0.084	-0.059
	(0.145)	(0.145)	(0.147)	(0.145)	(0.147)
Temporal Defenses					
Timing defense	0.059 ***	0.059 ***	0.053 ***	0.053 ***	0.050 ***
	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)
Timing defense^2	-0.008 ***	-0.008 ***	-0.007 ***	-0.008 ***	-0.007 ***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Social Defenses					
Structural social defense		0.096 **	0.185 ***	0.085 **	0.180 ***
		(0.052)	(0.062)	(0.051)	(0.062)
Positional social defense		-0.059	-0.069 *	-0.054	-0.071
		(0.051)	(0.051)	(0.060)	(0.060)
Structural Defense Impact					
Structural social defense * Secrecy defense			-1.945 ***		-1.797 ***
			(0.419)		(0.431)
Structural social defense * Patent defense			-0.393 **		-0.315 *
			(0.188)		(0.194)
Structural social defense * Timing defense			0.036 **		0.030 *
			(0.022)		(0.022)
Structural social defense * Timing defense^2			-0.005		-0.005
			(0.004)		(0.004)
Positional Defense Impact					
Positional social defense * Secrecy defense				-0.685 **	-0.326
				(0.405)	(0.406)
Positional social defense * Patent defense				-0.427 **	-0.265 *
				(0.190)	(0.193)
Positional social defense * Timing defense				0.039 **	0.030 *
				(0.021)	(0.022)
Positional social defense * Timing defense^2				-0.001	-0.0002
				(0.004)	(0.004)
Controls					
Round size	0.156 ***	0.162 ***	0.160 ***	0.157 ***	0.161 ***
	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)
Manufacturing intensity	0.655 ***	0.525 ***	0.506 ***	0.641 ***	0.502 ***
	(0.057)	(0.061)	(0.062)	(0.054)	(0.062)
Marketing intensity	0.714	0.389	0.529	0.511	0.480
	(0.628)	(0.632)	(0.633)	(0.632)	(0.634)
Age	0.012	0.008	0.011	0.013	0.011
	(0.029)	(0.030)	(0.029)	(0.029)	(0.029)
Calendar year	-0.028 ***	-0.026 ***	-0.028 ***	-0.028 ***	-0.027 ***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Biotechnology	0.229 **	0.274 **	0.282 **	0.240 **	0.280 **

	(0.111)	(0.111)	(0.111)	(0.111)	(0.111)
Electronics	0.446 ***	0.449 ***	0.460 ***	0.440 ***	0.457 ***
	(0.104)	(0.104)	(0.104)	(0.104)	(0.104)
Communications	-1.052 ***	-0.906 ***	-0.818 ***	-1.018 ***	-0.826 ***
	(0.207)	(0.217)	(0.217)	(0.203)	(0.217)
Software	0.272 **	0.279 ***	0.305 ***	0.251 **	0.295 ***
	(0.107)	(0.108)	(0.108)	(0.108)	(0.108)
Intercept	54.839 ***	50.612 ***	54.067 ***	54.043 ***	51.936 ***
	(12.722)	(12.500)	(12.539)	(12.779)	(12.663)
Deviance	2513.11	2507.49	2481.87	2497.78	2476.81
N	4077	4077	4077	4077	4077

* p < 0.10; ** p < 0.05; *** p < 0.01; one-tailed tests for main effects, two-tailed for controls. Robust standard errors are in parentheses.

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